Forest Products Laboratory

Our mission

We use science and technology to conserve and extend our Nation's forest resources. Our mission is to promote healthy forests and forest-based economies through the efficient, sustainable use of our wood resources. Many breakthrough technologies that influence the way we live started at the Forest Products Laboratory (FPL).

Our role and experience

Established in 1910 by the U.S. Department of Agriculture Forest Service, the FPL in Madison, Wisconsin, serves the public as the Nation's leading wood research institute. The FPL is recognized both nationally and internationally as an unbiased technical authority on wood science and use. Our research is concentrated in one location to promote an interdisciplinary approach to problem solving. The FPL cooperates with many universities, industries, and federal and state agencies.

Our areas of expertise

Today, more than 230 scientists and support staff conduct research on expanded and diverse aspects of wood use. Research concentrates on pulp and paper products, housing and structural uses of wood, wood preservation, wood and fungi identification, and finishing and restoration of wood products.

In addition to traditional lines of research, FPL is responding to environmental pressures on the forest resource by using cutting-edge techniques to meet important future challenges:

- Utilization of small-diameter timber
- Nanotechnology
- Biorefinery/bioenergy
- Advanced wood structures
- Advanced composites

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Durability and Wood Protection

Building Moisture and Durability Research

at the **Forest Products Laboratory**

USDA

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The development of new materials and building techniques during the 20th century resulted in numerous changes in wood structures. Changes in the timber resource dictated a shift from sawn wood and veneer products (such as plywood) to composites and engineered wood products (such as oriented strandboard). Although these newer products make more efficient use of our timber resource and can be made from small trees and underutilized wood species, their properties are not the same as those of sawn wood or products made from veneers—especially in regard to their response to moisture. Changes in building design and the introduction of non-wood building materials (such as foam insulation) have changed how building components interact while in service. Wood products specifications often have not kept pace with these changes. Proper design and use of wood products in home construction can improve durability and provide better and more energy-efficient housing. Changes in building codes can greatly affect the acceptance and expected service life of existing and new wood products.

Our building moisture and durability research program emphasizes four general areas:

- Building moisture design
- Corrosion of metal fasteners
- Moisture loads on buildings and moisture transport in materials
- Moisture durability of engineered wood products

Building Moisture and Durability Research

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Project researchers are active in several professional organizations and coalitions:

- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- ASTM International
- American Forest & Paper Association (AF&PA)
- Responsible Solutions to Mold Coalition (RSMC)
- Coalition for Advanced Wood Structures (CAWS)
- Forest Products Society (FPS)
- Society of Wood Science and Technology (SWST)
- The Minerals, Metals, and Materials Society (TMS)
- National Association of Corrosion Engineers (NACE)

Moisture durability of engineered wood products

Objectionable water-induced damage has sometimes been experienced with wood composition siding materials (such as hardboard), and with wood composition sheathing (such as oriented strandboard). Composite wood products are usually more sensitive to water than solid wood or veneered wood products. Faulty building design, improper construction practices, and ill-advised building operation are often partially responsible for product degradation. The products, however, sometimes show inconsistent resistance to water-induced damage. Industrial quality standards, if well-developed, can help ensure product consistency, and thus the likelihood of acceptable in-use performance.

Notable publications

Carll, C.; TenWolde, A. 2004. Durability of hardboard lap siding: Determination of performance criteria. Res. Pap. FPL–RP–622. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 29 p.

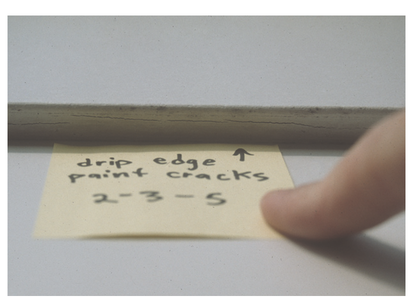
Carll, C.G.; Wiedenhoeft, A.C. 2007. Mechanical property loss and the occurrence of wood decay during experimental outdoor aging of wood-based panels. In: 41st International Wood Composites Symposium Proceedings [CD-ROM]. Pullman, WA: Washington State University.

Glass, S.V.; TenWolde, A. 2007. Review of in-service moisture and temperature conditions in wood-frame buildings. Gen. Tech. Rep. FPL–GTR–174. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Accelerated outdoor exposure (spray fence) for hardboard siding specimens.

Research highlights

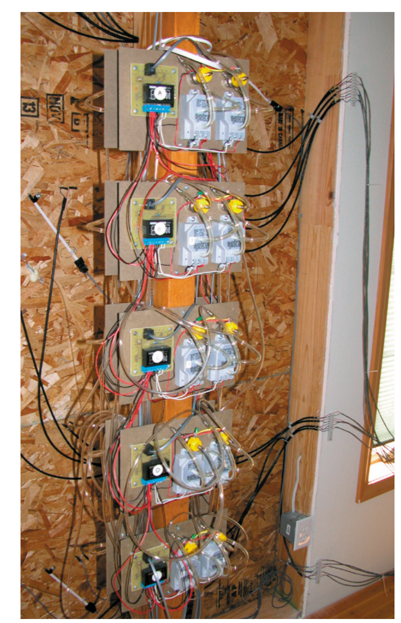
- Compile data on actual in-service conditions
- Acquire data on failure modes and failure rates for composite products in service
- Develop test methodologies to accurately assess durability



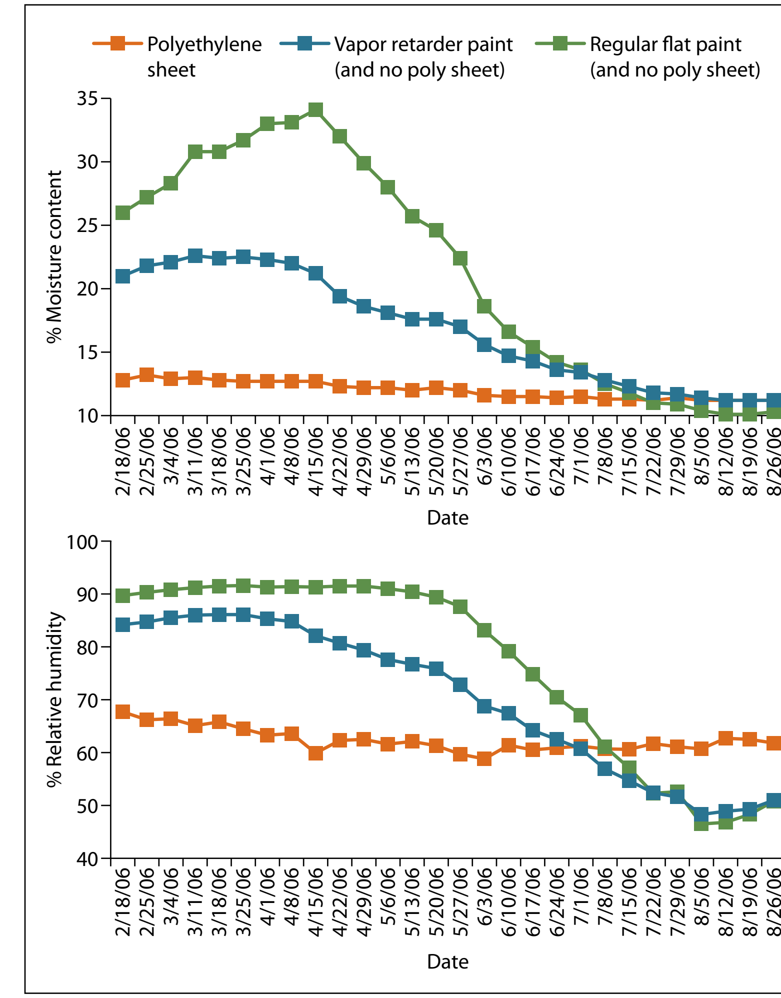
Paint cracks on the drip edge of a hardboard siding specimen after a few months of accelerated outdoor exposure.

Building moisture design

Housing should be safe, comfortable, energy efficient, affordable, and durable. Current guidelines for moisture control are often based on limited or outdated information and inadequate performance criteria, and they are often improperly applied to a wide range of climatic conditions. New technologies and guidelines are needed that minimize the potential for moisture damage to the structure and that maintain or improve energy efficiency and indoor air quality. Moisture and durability problems in buildings can vary greatly with climate, occupancy density (moisture loads), and construction variables. A performance-based moisture design approach for wood-frame buildings based on technical information and engineering principles needs to be developed.



Measuring pressure differentials across wall components.



Seasonal trends in moisture distribution in sheathing and relative humidity in wall cavities with various vapor barrier components.

Standards activities

- ASHRAE Proposed New Standard 160, Design Criteria for Moisture Control in Buildings
- ASTM E241-04, Standard Guide for Limiting Water-Induced Damage to Buildings
- ASTM E2266-04, Standard Guide for Design and Construction of Low-Rise Frame Building Wall Systems to Resist Damage Caused by Intrusion of Water Originating as Precipitation

Notable publications

Rose, W.; TenWolde, A. 2003. Venting of attics and cathedral ceilings. ASHRAE Journal 44(10): 26–33.

Corrosion of metal fasteners

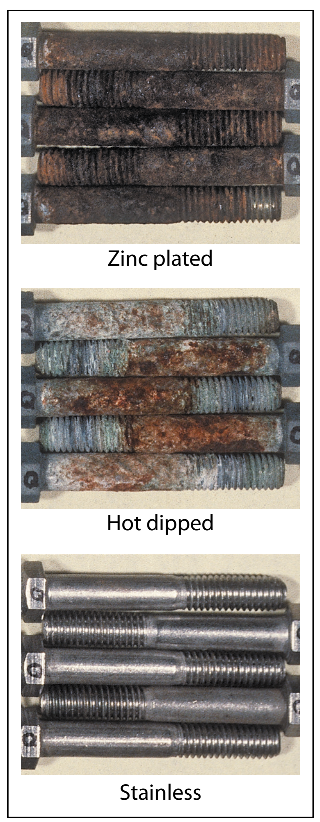
Since the voluntary withdrawal of chromated copper arsenate (CCA) for residential applications, many designers are now using alternatives to CCA such as alkaline copper quaternary (ACQ) or alkaline copper azole (CuAz). Due to the lack of chromium and the increased copper in their formulations, these new preservatives are potentially more corrosive than CCA. The current standard method for measuring corrosion of metals in contact with treated wood involves placing wood in contact with metals at high temperatures and humidity. However, it has been shown that this method has poor correlation to in-service performance. Corrosivity of treated wood needs to be quantified for proper design and operation of residential and non-residential wood structures to prevent failures.

New methods are needed that accurately predict corrosiveness of preservative systems in order to

- Screen new preservative systems
- Assess new fasteners for corrosion resistance.

Joist hanger in boardwalk 1 month after installation.

Corrosion of galvanized bridge hardware in contact with amine copper-treated lumber after 3 years of service.



Comparative corrosion of metal fasteners in wood treated with a copper-based preservative in-service for 1 year.

Notable publications

Zelinka, S.L.; Rammer, D.R. 2005. Review of test methods to determine the corrosion rate of metals in contact with treated wood. Gen. Tech. Rep. FPL–GTR–156. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 23 p.

Zelinka, S.L. 2007. Uncertainties in corrosion rate measurements of fasteners exposed to treated wood at 100% relative humidity. Journal of Testing and Evaluation 35(1):106–109.

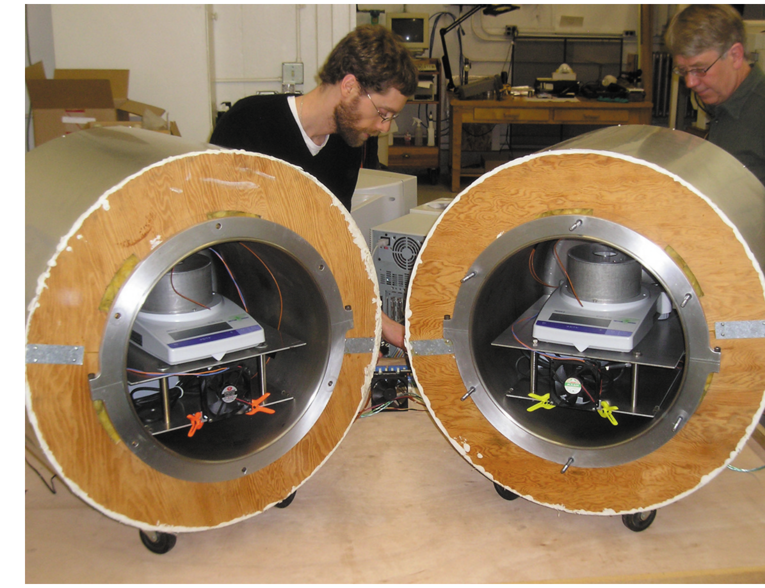
Moisture loads on buildings and moisture transport in materials

The balance between wetting and drying of a building component influences the likelihood that it will suffer moisture-induced damage. Most buildings will experience some wetting during their service lives. Their components should thus be expected to tolerate wetting within some reasonable limits. Drying rate can greatly influence the degree of wetting that a component can tolerate. Computer simulation models can be used to predict moisture and temperature conditions within components over time, and the models are becoming both more sophisticated and user-friendly. However, computer models are dependent on adequate characterization of their input parameters, which include moisture loads (both interior and exterior) and material properties among others. The moisture transport properties of most building materials are currently not well characterized under conditions where they are exposed to gradients in both temperature and relative humidity.

Notable publications

Carll, C. 2000. Rainwater intrusion in light-frame building walls. In: Proceedings of the 2nd Annual Conference on Durability and Disaster Mitigation in Wood-Frame Housing. Madison, WI: Forest Products Society: 33–40.

TenWolde, A.; Walker, I.S. 2001. Interior moisture design loads for residences. In: Proceedings for Performance of Exterior Envelopes of Whole Buildings VIII [CD-ROM]. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.



Permeability experiments will cover a broad range of realistic in-service temperature and humidity conditions for sheathing materials.

Research highlights

- Compile data on the effect of air leakage on wetting and drying
- Determine wetting and drying rates of solid and composite building components, with emphasis on joints between structural components
- Develop enhanced drying strategies
- Develop strategies to minimize wetting
- Acquire laboratory measurements of hygrothermal properties of wood products
- Create a database on properties for use in hygrothermal models and building design

Moisture distribution analysis in wall cavities.